

## Supplement to CR-102 Submission

# Ergonomics Rulemaking is Good Sense and Good Science

This document is a supplement to the CR-102 submission for the Washington State Department of Labor & Industries' (L&I) proposed ergonomics rule. L&I prepared this supplement to describe more fully the reasons why work-related musculoskeletal disorders (WMSDs) need to be addressed through regulation. This supplement reviews the scientific evidence supporting the link between risk factors at work and WMSDs, and explains the considerations that led to the proposed rule.

### Overview<sup>1</sup>

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**Work related musculoskeletal disorders (WMSDs) that adversely affect workers are a widespread problem in Washington workplaces.**

Strong scientific evidence indicates that jobs and tasks with known risk factors such as frequent, heavy lifting; forceful, repetitive motions; awkward postures; contact stress; high hand force; and vibration expose workers to preventable hazards that cause or aggravate work related musculoskeletal disorders (WMSDs).

For example, in a 1997 publication the National Institute for Occupational Safety and Health (NIOSH) evaluated more than 2000 scientific publications and reviewed 600 epidemiological studies in detail. NIOSH concluded that “a substantial body of credible epidemiological research provides strong evidence of an association between musculoskeletal disorders and certain work related physical factors when there are high levels of exposure and especially in combination with exposure to more than one physical factor (e.g., repetitive lifting of heavy objects in extreme or awkward postures).” (Bernard, 1997).

Seventy-four leading scientists who attended a National Academy of Sciences (NAS) workshop in 1998 also reviewed the evidence. The NAS report concluded: “looking at studies with the highest level of exposure...the positive relationship between musculoskeletal disorders and the conduct of work is clear.” (National Research Council, 1999).

WMSDs are among the most common and costly occupational injuries and illnesses in the State of Washington. Non-traumatic soft tissue WMSDs such as tendinitis, carpal tunnel syndrome and

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<sup>1</sup> Note: The ergonomics rule being proposed by the Department of Labor & Industries must meet all criteria and requirements established by the Washington Industrial Safety and Health Act (Chapter 49.17 RCW) and the Administrative Procedures Act (Chapter 34.05 RCW). This preliminary analysis represents L&I's judgments about the rulemaking criteria based on the best information available to the department at this time. After the public hearings and comment period, L&I will make additional analyses and determinations before completing the rule. Where appropriate, the final rule may differ from the proposal.

low back disorders alone account for 32 percent of all workers' compensation claims accepted by the Washington State Department of Labor and Industries (L&I) and 46 percent of all claims costs. There are over 50,000 such claims each year. WMSDs are the leading source of injury and illness to Washington workers for which there are no specific regulations.

Unless otherwise noted, references in this document to work-related musculoskeletal disorders (or WMSDs) mean non-traumatic soft tissue disorders and exclude injuries from slips, trips, falls, motor vehicle accidents or being struck by or caught in objects.

**There are effective, affordable, and available methods of preventing these WMSDs.**

Strong evidence demonstrates that applying the principles and tools of ergonomics to known risk factors such as frequent, heavy lifting; forceful, repetitive motions; awkward postures; contact stress; high hand force; and vibration can effectively reduce the hazards to workers and thereby prevent many WMSDs.

For example, in response to a congressional request, the U.S. Government Accounting Office (GAO) in 1997 studied private sector ergonomics programs. The GAO concluded that these programs yielded positive results: "Our work has demonstrated that employers can reduce these costs and injuries and thereby improve employee health and morale, as well as productivity and product quality...We found that these effects do not necessarily have to involve costly or complicated processes or controls, because employers were able to achieve results through a variety of simple, flexible approaches." (U.S. GAO, 1997).

The NAS workshop cited earlier found: "There is compelling evidence from numerous studies that as the amount of exposure to hazards is reduced the development of musculoskeletal disorders is reduced. There are a variety of actions that can be taken in the workplace to eliminate or reduce the risk of musculoskeletal disorders." (National Research Council, 1999).

**The magnitude of the problem requires comprehensive action to reduce these disorders. Part of the action must be government regulation and enforcement because previous non-regulatory efforts have not adequately lowered the incidence of WMSDs.**

In the 1980s, L&I recognized the need to provide information and technical assistance to employers to help control WMSD hazards. L&I efforts to encourage voluntary control of these hazards have included published guidelines, other informational materials, free on-site consultation, workshops, research and other forms of technical assistance. After ten years of offering these resources, L&I surveyed approximately 5000 employers and found that 60 percent still report no efforts to control WMSD hazards. Even among employers who recognized WMSD hazards in their workplaces, 40 percent reported no control efforts. The survey results also showed that many employers who made efforts to control WMSD hazards have chosen relatively less effective methods such as personal protective equipment. L&I concluded that voluntary efforts have been useful and remain necessary, but they are not sufficient. A fully comprehensive and effective ergonomics effort in Washington State requires regulation and enforcement.

L&I's current enforcement efforts to reduce WMSD hazards rely on WAC 296-24-040 (Accident Prevention Programs), WAC 296-24-020 (Management's Responsibility) and WAC 296-24-073 (Safeplace Standards). These general regulations are not adequate to reduce WMSDs because they do not provide employers, employees or L&I staff with clear enough guidance about the exposures employers must control and how the department will assess compliance. Business organizations have argued that if L&I intends to use its authority to require employers to reduce WMSD hazards it must issue new, more specific rules instead of relying upon the existing general ones.

**The proposed rule takes a flexible approach that reflects public input.**

L&I began the rule development process in October 1998. The department's objective was to develop a proposed rule that would be fair, feasible and flexible. Before drafting the proposed rule, L&I actively engaged the business, labor and health professional communities in detailed discussions. These discussions included nine public stakeholder meetings around the state in late 1998, which were followed by the work of two advisory committees in the first half of 1999. Although the advisory committees did not reach consensus, their work led to 15 "promising ideas" that L&I used as benchmarks for this proposed rule.

The ergonomics rule proposal has eight key elements:

1. The rule will apply only to employers with "caution zone jobs," those where any employee's typical work includes physical risk factors specified in the rule. "Caution zone jobs" are not prohibited and they may not be hazardous.
2. Employers with "caution zone jobs" must ensure that employees working in or supervising these jobs receive ergonomics awareness education. These employers also must analyze the caution zone jobs to determine if they have hazards.
3. If jobs have WMSD hazards the employer must reduce exposures below hazardous levels or to the degree feasible.
4. Employers may choose their own method and criteria for identifying and reducing WMSD hazards or may use the department's specified criteria.
5. Employers must provide for and encourage employee participation in activities required by the rule.
6. An extended implementation schedule based on industry type and employer size allows employers, especially small businesses, ample time to prepare for compliance.
7. The department will work with Demonstration Employers to test and improve ergonomics guides and models, industry best practices, and inspection policies and procedures as they are developed.
8. Employers may continue to use methods of reducing WMSD hazards that were in place before the rule adoption date as long as the methods, taken as a whole, are as effective as the requirements of the rule.

**The department considered and rejected several alternatives to the proposed rule.**

L&I considered several non-rulemaking alternatives. Expanding voluntary ergonomics activities was an option. Using existing general rules more often - with clearer enforcement policies - was another. A third was to wait for a federal ergonomics rule. Rulemaking alternatives included an injury-based rule, a rule exempting construction and agriculture, a rule exempting small businesses, a specification-based rule with no employer choice and a general performance rule with no employer guidance. The department decided that the proposed rule is likely to be the most effective and least burdensome alternative.

**The cost of not regulating WMSDs far exceeds the costs of the proposed rule.**

This rule will have major impact because uncontrolled hazards leading to WMSDs exist in a wide range of workplaces and because the rule will apply to industries of all types and sizes. For these reasons, the total statewide costs of this rule will be significant. However, the cost per employee is estimated to be less than 10 cents per day and the overall cost per employer less than 0.025 percent of sales. Moreover, the cost of regulation is far smaller than the cost of no regulation. The annual direct costs (medical costs and partial wage replacement) of industrial insurance claims for the types of WMSD claims addressed by the proposed rule are greater than \$340 million (\$288 million for State Fund employers and \$52 million for Self-Insured employers). The actual total cost is much higher as insurance payments do not fully compensate workers for lost time and income. In addition there is evidence that workers make sizable out of pocket payments to treat WMSDs. Also, L&I's data does not include the cost of non-compensable (medical only) claims for self-insured employers. Finally, it is widely believed that the indirect costs of workplace injury (such as lost productivity, reduced quality, increased personnel turnover and training) are 2-4 times the direct costs. Therefore, a conservative estimated range for the total costs of WMSDs addressed by this rule is from \$500 million to \$1 billion yearly.

L&I has not yet conducted the formal benefit-cost analysis required for publication of a new significant legislative rule. However, the vast and growing literature reporting success rates for well-designed workplace ergonomics activities gives L&I confidence that this proposed ergonomics rule will improve employee health at reasonable costs. L&I believes the benefits of this rule will outweigh its costs. Therefore, it is prudent for L&I to publish the proposed rule. After the full process of public review and comment has concluded, the department will make a final determination of whether benefits exceed costs and whether to adopt this rule, with or without changes. L&I will base this determination on the best available evidence in the rulemaking file after public comments.

## **Ergonomics rulemaking is consistent with the general goals and specific objectives of the Washington Industrial Safety and Health Act (Chapter 49.17 RCW).**

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The statutory basis for the proposed rule is Chapter 49.17 RCW. The goal of the statute is to provide a safe and healthful workplace for all working men and women in the state. It provides for the development of safety and health standards that will assure, to the extent feasible, and on the basis of the best available evidence, that no employee will suffer material impairment of health or functional capacity even if any such employee has regular exposure to the hazard dealt with by such standard for the period of their working life.

In addition, the statute specifies that, where appropriate, safety and health standards will prescribe suitable protective equipment and control or technological procedures to be used in connection with such hazards and shall provide for monitoring or measuring employee exposure at such locations and intervals, and in such manner as may be reasonably necessary for the protection of employees.

Parts of the statute that state the goals and objectives this rule implements are:

- RCW 49.17.010, Purpose
- RCW 49.17.040, Rules and regulations - Authority - Procedure
- RCW 49.17.050, Rules and regulations - Guidelines - Standards
- RCW 49.17.240, Safety and health standards

## **The proposed rule is needed in order to achieve department goals.**

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**One of L&I's four departmental priorities is "Safe workplaces: Saving lives and preventing injuries and illnesses."**

One of the department's five strategies for achieving this priority is to "Develop and implement a comprehensive approach to musculoskeletal problems."

**WMSDs are painful and disabling. They affect employees' productivity at work and quality of life at home.**

Musculoskeletal disorders are injuries and illnesses that involve the bones, joints, muscles, tendons, nerves and supporting structures. Work-related musculoskeletal disorders (WMSDs), for the purpose of this rulemaking, are the non-traumatic soft tissue subset of musculoskeletal disorders. Examples include carpal tunnel syndrome, tendinitis, rotator cuff syndrome, and low back strain. Exposure to physical risk factors at work, such as frequent, heavy lifting; forceful, repetitive motions; awkward postures; contact stress; high hand force; and vibration cause or aggravate these WMSDs. These disorders often develop in workers whose jobs involve repetitive tasks or manual handling. WMSDs may occur after hours, days, months or years of exposure.

The symptoms of these disorders may appear to have a sudden onset or they can develop over a long period of time.

WMSDs do not kill workers but they can have devastating impact on their lives and livelihoods. The cardinal signs and symptoms include pain, motor weakness, sensory deficits and restricted ranges of motion. While these can be severely debilitating, they can interfere with both work and family life even in modest, early stages.

A worker in pain loses the ability to concentrate with the consequence of declining quality and productivity at work. A worker with muscle weakness will struggle to perform manual tasks and may not be able to perform them at all. A worker with damaged nerves loses accuracy and placement in fine manipulative work, becomes clumsy and inaccurate, and finds difficulty in responding quickly and precisely to danger. A worker with restricted movement cannot complete tasks or can only complete them by adopting awkward, unnatural postures which themselves cause additional problems.

Making matters worse, all of these functional deficits at work are brought home at the end of the day. Pain, weakness, sensory loss and limited movements can all interfere with family responsibilities and relationships. Fathers and mothers may lose the ability to hold their children. They may not be able to prepare meals, maintain a clean home, perform household maintenance, or enjoy their hobbies. Physical limitations can lead to emotional stress, damaged relationships and loss of self worth.

Three examples are illustrative:

1. Carpal tunnel syndrome is a classic entrapment neuropathy, caused by compression of the median nerve as it passes under the transverse carpal ligament on the flexor side of the wrist. Numbness, tingling, and pain in the fingers are common features, often waking the worker in the middle of the night. Aching pain may radiate into the forearm and may be worsened by manual activity, particularly bending or flexing the wrist. Sensory disturbances may be followed by muscle weakness and atrophy. The pain, reduced motor strength and disturbed sensory feedback can interfere with the ability to perform fine manual tasks such as light assembly work, keying or sewing. As the condition progresses with muscle wasting and increased pain, everyday activities such as driving a car or even dressing can become excruciating or even impossible. Workers with carpal tunnel syndrome may be treated with work restrictions, wrist splints, anti-inflammatory medications, physical therapy, or corticosteroid injections. Surgical release of the carpal ligament may relieve the symptoms but may not return ability to work. Despite aggressive treatment workers may experience temporary or permanent total disability.
2. Lateral and medial epicondylitis are the terms for inflammatory disorders of the tendons that connect the muscles of the forearm with the bone of the upper arm (humerus). Pain and tenderness may be so severe that simple movements or exertions such as reaching for parts or handling control knobs become impossible. Treatments include short or prolonged periods of rest, oral anti-inflammatory drugs, physical therapy, anesthetic and corticosteroid injections, or surgical release procedures.

3. Sciatica is impingement of the sciatic nerve, often by a herniated disc in the lumbar spine, as the nerve root leaves the spinal cord. Severe pain radiating down one or both legs may cause difficulty in sitting or walking, worsened by bending or twisting. Patients often complain of pain, numbness, and weakness that are only relieved when confined to bed or in a flexed position. Conservative treatments such as limited physical activity, non-steroidal anti-inflammatory drugs, muscle relaxants and opiates, or spinal manipulation are sometimes effective. Many workers with sciatica experience prolonged or repeated periods off work. Surgical intervention may be required if disc herniation has been confirmed, in some cases shortly after symptoms began, sometimes after some weeks or months, and sometimes as a last resort after other treatments fail.

**WMSDs occur in Washington workplaces in numbers and at rates that are too high for government to ignore. They are widespread and preventable.**

WMSDs and their risk factors have been identified in all industry sectors (Bernard 1997; Silverstein and Kalat, 1999a; Foley and Silverstein, 1999). Workers compensation data and Bureau of Labor Statistics (BLS) reports both tend to underestimate the magnitude of the problem in the U.S. (Silverstein 1997; Morse, 1998; Pransky 1999). There are a number of disincentives for workers and health care providers to report problems, including fear of reprisals, loss of income, change in job status, peer pressure, and paperwork.

L&I's State Fund accepted 426,806 workers' compensation claims for non-traumatic soft tissue WMSDs from 1990-1997, or well over 50,000 such claims each year (Silverstein & Kalat, 1999 b). This represents 32 percent of all accepted claims in the State Fund and 46 percent of accepted claims costs. Total direct workers' compensation costs over 1990-1997 were \$2.3 billion. Time loss for WMSDs during 1990-1997 exceeded 20 million lost workdays, accounting for 54 percent of all lost workdays over this period.

For the self-insured companies (approximately 400 of the largest companies, employing about one-third of the workforce in Washington), the number of WMSD compensable claims (resulting in 4 or more lost workdays) between 1990-1997 was 89,299, accounting for 59 percent of accepted compensable claims. These self-insured compensable claims resulted in almost 5 million lost workdays during 1990-1997, and claim costs exceeded \$417 million. This is most likely an underestimate because data on compensable claims from the self-insured employers are not available to L&I until after they have been closed. The average yearly compensable claims incidence rate, available for 1992-1997, was 20.8 per 1,000 FTEs.

Among State Fund employers the average number of these kinds of WMSD claims has been 53,351 per year with an incidence rate of 43.2 per 1,000 fulltime equivalent employees (FTEs). The highest rate has been for back WMSDs (18.4 per 1,000 FTEs), followed by neck and upper extremity WMSDs (17 per 1,000 FTEs) and lower extremity WMSDs (5.5 per 1,000 FTEs). Rates for specific diagnoses (ICD-9) include 2.8 per 1,000 FTEs for carpal tunnel syndrome, 2.1 per 1,000 FTEs for rotator cuff syndrome, 1.3 per 1,000 FTEs for epicondylitis and 0.6 per 1,000 FTEs for sciatica (Silverstein and Kalat, 1999a).

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Although the rate for all claims has been decreasing in Washington State and elsewhere, the rate of decrease for these non-traumatic soft tissue claims has been less (22.2% overall WMSD and 28.2% for all state fund claims). Neck and upper extremity disorders have decreased only 5.8 percent during this eight-year period. The proportion of all claims represented by WMSDs has been steady or increasing.

Table 1 shows the combined State Fund and Self-Insured compensable claims for the top 20 3-digit SIC industries by prevention index rank. The prevention index averages the rank based on the incidence rate and the rank based on the total number of claims. For example, a very small industry may have a high rate but a small number of claims while another, larger industry with more workers may have a large number of claims but a low incidence rate. Averaging these rankings is a reasonable approach to identifying industries where the overall impact of WMSDs and the opportunity for prevention is the greatest. For an industry to have a high prevention index rank it must have relatively high numbers of WMSDs and relatively high incidence rates of WMSDs. Appendix A provides additional data on the numbers and rates of WMSDs in various industries, along with their prevention index rankings.

Standard industrial classification codes (SICs) were developed for purposes of commerce and not for estimating hazardous exposures. It is likely that some “high risk” occupations or jobs are contained within industry classifications that might be classified as “low risk.” For example, janitors and maintenance employees working for a financial company are exposed to many of the manual handling risk factors of concern but would be classified under “finance, insurance and real estate.”

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**Table 1. Three Year Claims Incidence Rates for Compensable (4 or more lost workdays) Non-traumatic Soft Tissue WMSD Claims in Washington State, 1995-1997. 3-digit SIC by Prevention Index (PI) for WMSDs per 1,000 FTEs**

PI Rank	Neck & Upper Extremity		Low Back		Lower Extremity		All Non-traumatic Soft tissue WMSDs	
	SIC Industry	Claims Rate	SIC Industry	Claims Rate	SIC Industry	Claims Rate	SIC Industry	Claims Rate
1	451 Air transportation scheduled & air courier services	19.6	421 Trucking & courier services, except air	24.3	421 Trucking & courier services, except air	7.9	421 Trucking & courier services, except air	49.6
2	421 Trucking & courier services, except air	10.5	805 Nursing & Personal care facilities	22.4	451 Air transportation scheduled & air courier services	7.7	451 Air transportation scheduled & air courier services	54.5
3	541 Grocery Services	11.4	451 Air transportation scheduled & air courier services	21.6	171 Plumbing, heating, air conditioners	5.6	805 Nursing & Personal care facilities	37.6
4	805 Nursing & Personal care facilities	11.8	152 General contractors-residential	16.5	152 General contractors-residential	5.4	174 Masonry, stone, tile & plastering	36.0
5	174 Masonry, stone, tile & plastering	12.5	174 Masonry, stone, tile & plastering	17.6	823 Libraries	5.0	152 General contractors-residential	32.2
6	201 Meat products	16.3	176 Roofing, siding, sheet metal	28.2	913 Exec & legislative offices	4.9	176 Roofing, siding, sheet metal	50.0
7	242 Sawmills & planing mills	12.5	175 Carpentry & floor work	19.0	176 Roofing, siding, sheet metal	8.7	541 Grocery Stores	27.4
8	823 Libraries	11.1	734 Services to dwellings & other buildings	15.3	174 Masonry, stone, tile & plastering	5.5	175 Carpentry & floor work	37.5
9	152 General contractors-residential	10.2	177 Concrete work	24.4	175 Carpentry & floor work	6.0	734 Services to dwellings & other buildings	28.8
10	373 Ship & boat building/repair	15.1	179 Misc Special trade contractor	13.8	179 Misc Special trade contractor	4.6	411 Local & suburban passenger transport	43.8
11	175 Carpentry & floor work	12.3	836 Residential care	15.2	411 Local & suburban passenger transport	6.8	177 Concrete work	43.8
12	411 Local & suburban passenger transport	15.5	162 Heavy construction except highway	13.9	495 Sanitary services	7.5	242 Sawmills & planing mills	30.1
13	335 Rolling, drawing, extruding nonferrous metals	16.3	541 Grocery Services	11.9	162 Heavy construction except highway	4.3	836 Residential care	29.1
14	262 Paper mills	12.6	411 Local & suburban passenger transport	20.1	241 Logging	3.8	823 Libraries	26.3
15	209 Misc Food prep & kindred products	11.5	702 Rooming & boarding houses	15.1	919 General government NEC	3.1	179 Misc Special trade contractor	26.9
16	177 Concrete work	15.0	171 Plumbing, heating, air conditioners	12.7	173 Electrical work	3.5	335 Rolling mills	42.9
17	913 Exec & legislative offices	9.2	806 Hospitals	10.6	792 Theatrical producers (except motion pictures)	12.4	171 Plumbing, heating, air conditioners	25.7
18	836 Residential care	11.2	518 Beer, wine & other beverages	16.7	541 Grocery Stores	2.9	913 Exec & legislative offices	32.3
19	243 Millwork, veneer, plywood	10.2	521 Lumber & building material dealers	11.6	262 Paper mills	4.6	262 Paper mills	35.1
20	806 Hospitals	8.1	335 Rolling mills	16.3	242 Sawmills & planing mills	4.2	373 Ship & boat building/repair	26.2
Industry-wide Rate		5.8		6.9		2.2		15.3

## **Strong scientific evidence indicates that workers doing jobs and tasks with known risk factors are exposed to preventable hazards that cause or aggravate WMSDs.**

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Many of the relationships between physical risk factors and adverse health effects were first observed by clinicians in case series reports or from reviews of workplace medical data. As early as 1713, Ramazzini described "...certain violent and irregular motions and unnatural postures of the body, by reason of which, the natural structure of the vital machine is so impaired that serious diseases gradually develop therefrom". (p. 435)

In the last 20 years an enormous number of laboratory and epidemiologic studies have demonstrated the relationship between work-related factors and musculoskeletal disorders. Much of this scientific data has been critically evaluated (Bernard 1997, NRC 1999, Kuorinka & Forcier, 1995, Riihimaki & Viikari-Juntura, 1999, Punnett and Bergqvist 1997, Keyserling, 2000a and 2000b in press). In addition, population surveys have been used to assess the magnitude of the problem across industries and occupations (BLS Occupational Injury and Illness Survey, National Health Interview Survey, etc.). Epidemiologic studies have looked at the relationships between workplace exposures and outcome such as symptoms, physical examination findings, specific diagnoses, or disability while controlling for potential confounders and effect modifiers such as gender, age, injury and medical history.

Many WMSDs are often multifactorial with more than one risk factor contributing to cause or aggravate the condition. Non-work factors sometimes play an important role. The interaction of factors may result in reduced blood flow, ischemia (cell death), inflammation, degeneration, restricted movements leading to temporary or permanent damage to muscles, tendons, ligaments, cartilage, blood vessels, or nerves. Adequate recovery time increases soft tissue tolerance of physical loads. A given load may be harmful only when combined with inadequate recovery periods (Armstrong et al, 1993).

Risk factors are generally evaluated in terms of how much, how long and how frequently they occur and sometimes if they occur in combination with other risk factors, to determine whether they are hazardous. Limited exposure may not be harmful and may result in a training effect. The combined effects of the physical risk factors, modified by intensity and duration, tax the recovery and repair capacities of the body. Inadequate rest schedules deprive the body of recovery time to accomplish repair on strained tissues. The pattern of exposure can be as important as total magnitude or cumulative exposure. For instance, cumulative exposure duration of 4 hours, spread over two 8-hour work days, can be associated with substantially different health effects than a single, one-time exposure of 4 hours.

### **Individual Factors**

Workplace psychosocial factors (high psychological demands with low decision latitude, low social support), individual factors (size and shape, age, gender), and non-work activities (sports, hobbies) are other factors that can contribute to the WMSD multifactorial disease process.

Individual factors that contribute to WMSDs include age, gender, some systemic diseases, anatomic differences, and obesity. With age, there is degeneration of the spine. In the shoulder, the blood flow decreases in the rotator cuff, resulting in reduced nutrition. In the wrist area, the carpal joints undergo degenerative changes with age that may lead to a reduced volume in the carpal tunnel. These changes make the tissues more liable to harmful effects of repeated exertions and awkward postures. Workplace physical stresses can produce effects associated with aging, such as decreased blood flow, impaired nutrition and degeneration, even in young workers. While increasing age may be a risk factor, in many workers it is countered by increased skill level that minimizes physical load compared to inexperienced, younger workers.

Some neck disorders and carpal tunnel syndrome are more commonly reported among women than among men. There is some evidence that women might be more vulnerable to other soft tissue disorders of the arm. A biologically plausible explanation could be a weaker muscle force of the upper limbs of women, which would expose women at higher proportional loads of maximal capacity than men during a given task. Low back disorders are more commonly reported by men and may be due to the longer and heavier torso that, when bent, increases the load on the back muscles. In only a few studies has it been possible to look at differences between women and men, because they usually have different work tasks. Some gender differences obtained in studies may in fact be due to physical load factors not measured in the study.

### **Overview of Physical Risk Factors for Work Related Musculoskeletal Disorders.**

A large number of studies demonstrate a dose-response relationship between physical risk factors at work and WMSDs. Punnett (1998) studied WMSD prevalence using an exposure index that combines multiple risk factors: work pace repetitiveness, grip force, postural stressors, contact stress, vibration, and machine-pacing of work. The prevalence of WMSDs increased markedly as the number of risk factors increased. Similar indexes have been developed by McAtamney and Corlett (1993) in their Rapid Upper Limb Assessment (RULA) tool, by Moore and Garg (1994) in their distal upper extremity Job Strain Index, Liles (1984) for a Back Job Severity Index, and by NIOSH in the 1991 Lifting Equation (Waters 1993, 1999, NIOSH 1994). It follows from this body of work that multifactorial interventions will often reduce incidence of disorders more effectively than interventions targeting only a single risk factor.

In 1997, the National Institute for Occupational Safety and Health (NIOSH) identified over 2,000 studies, examined over 600 epidemiologic studies and published a comprehensive review of the epidemiologic studies of back and upper extremity musculoskeletal disorders and occupational exposures (Bernard 1997). The criteria used to assess this literature included: 1) strength of the association, 2) coherence of evidence or biological plausibility, 3) consistency with other research, 4) temporality or appropriate time sequence, 5) specificity of effect or association, and 6) dose-response relationship (biologic gradient).

NIOSH concluded that there was adequate evidence for causal relationships between musculoskeletal disorders of several body regions and repetitive motion, forceful exertions, non-neutral postures, vibration, and combinations of occupational exposures (Table 2). “A substantial body of credible epidemiologic research provides strong evidence of an association

between MSDs and certain work-related physical factors when there are high levels of exposure and especially in combination with exposures to more than one physical factor (e.g., repetitive lifting of heavy objects in extreme or awkward postures.” (page xiv).

**Table 2. Summary of NIOSH Review of Epidemiologic Evidence for Upper Extremity and Low Back MSDs (Bernard, 1997)**

<b>MSD Location or Diagnosis</b>	<b>Number of Studies</b>	<b>Force</b>	<b>Static or Extreme Postures</b>	<b>Repetition</b>	<b>Vibration (Segmental)</b>	<b>Combination</b>
<b>Neck and Neck/Shoulder</b>	> 40	++	+++	++	+/0	(--)
<b>Shoulder</b>	> 20	+/0	++	++	+/0	(--)
<b>Elbow</b>	> 20	++	+/0	+/0	(--)	+++
<b>Carpal Tunnel</b>	> 30	++	+/0	++	++	+++
<b>Hand/Wrist Tendinitis</b>	8	++	++	++	(--)	+++
<b>Hand-Arm Vibration Syndrome</b>	20	(--)	(--)	(--)	+++	(--)
<b>MSD Location or Diagnosis</b>	<b>Number of Studies</b>	<b>Heavy Physical Work</b>	<b>Lifting and Forceful Movements</b>	<b>Static Postures</b>	<b>Awkward Postures</b>	<b>Vibration (Whole Body)</b>
<b>Low Back</b>	> 40	++	+++	+/0	++	+++

Note: +/0 means insufficient evidence, ++ means evidence for causal relationship, +++ means strong evidence of a causal relationship, (--) means the association is not reported in the NIOSH publication.

In 1998, the National Academy of Sciences (NAS) convened a symposium of 74 researchers and ergonomics practitioners to evaluate the research base including the NIOSH review. The NAS report (NRC 1999) found that despite some study limitations, the preponderance of evidence from studies with high exposure contrasts among study groups supports the association between work-related physical factors and MSD development. NAS also concluded that the demonstrated reduction of MSDs in workplaces where these risk factors were reduced strongly supports the association between workplace risk factors and WMSDs.

The NAS report said: “Looking at studies with the highest level of exposure...the positive relationship between musculoskeletal disorders and the conduct of work is clear. There is compelling evidence from numerous studies that as the amount of exposure to hazards is reduced the development of musculoskeletal disorders is reduced. There are a variety of actions that can be taken in the workplace to eliminate or reduce the risk of musculoskeletal disorders.”

## Descriptions of physical risk factors.

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### **High Force**

Force is the mechanical effort required to carry out a movement or to prevent movement. High grip force has been shown to be an independent risk factor of carpal tunnel syndrome (CTS) in epidemiological studies. Experimental studies in the laboratory have shown that carpal tunnel pressure increases as a reaction to exertion of force, especially in pinching activities (Viikari-Juntura and Silverstein 1999). Studies have shown an association between degenerative neck disorders and low back disorders and heavy physical work, such as heavy or frequent lifting (Riihimäki and Viikari-Juntura 1999). Exertion of high hand forces combined with highly repetitive wrist or hand movements greatly increases the risk of CTS and wrist tendinitis. A number of studies have reported high occurrence of elbow and wrist disorders in jobs that involve repetitive forceful movements in awkward postures (Bernard 1997).

The dynamic act of lifting a work piece and the static act of holding that work piece in position both require force, generated by muscles, transmitted through tendons, and exerted by the body on the work piece. Force causes tension, shear force, friction, and irritation on tendons and tendon sheaths, as well as strain at the insertion of tendons on bones. Job tasks can affect muscle force. For example, holding a 2-pound object in a pinch grip is equivalent in muscle force production to holding a 10-pound load in a power grip. Similarly, gripping an object in a flexed wrist position requires more force than gripping in a neutral wrist position.

Deviations from a “neutral posture” can dramatically reduce the amount of muscle force translated into output force. Skilled, small-motor activities such as in keying, pipetting, fine sewing or electronics assembly tasks, involve co-contraction of several muscles to generate precisely graded movements, joint stabilization, or holding forces. Thus, substantial muscle activity can be associated with very little net output force. For example, measurements of the weight of a work piece or the finger forces necessary to move a computer mouse may substantially underestimate the potential damage to the muscles, tendons, joints and other soft tissues involved. Cold temperatures and segmental vibration increase hand force requirements largely because they interfere with sensory feedback to the fingers so tools are gripped harder.

The full impact of forceful manual handling tasks on the back depends on several factors (Snook and Ciriello, 1991; NIOSH, 1994; Marras, 1995):

- Distance and location of the load from the spine. The greater the distance, the greater is the lever arm or torque.
- Weight of the external load.
- Frequency of lifting/lowering.
- Speed of motion (velocity) and rate of acceleration/deceleration.
- Awkward postures during the lifting/lowering such as twisting and bending to the side or front.
- Coupling of the hands to the object (use of handles improves coupling).

The 1991 NIOSH Lifting Index (Waters, 1993, 1994) takes into account most of these factors. The criteria for a Lifting Index of 1.0 was set so that “nearly all healthy workers could perform over a substantial period (e.g., up to 8 hours) without an increased risk of developing lifting-related LPB (low back pain).” The lifting index of 1.0 is estimated to protect 75 percent of healthy adult females and 99 percent of healthy males. A Lifting Index of 2.0 is expected to protect 20 percent of females and 80 percent of males, and a Lifting Index of 3.0 is expected to protect 1 percent of females and 27 percent of males. Liberty Mutual researchers (Ciriello and Snook, 1999) summarized manual handling activities of 2,442 industrial locations. The median lifting and lowering tasks were 1.9 and 1.8 using the NIOSH Lifting Index, indicating a need for job redesign. Most lifting, lowering and carrying tasks were unacceptable for a large proportion of the female industrial population and some of the male population. Median pushing and pulling tasks were acceptable to a large percentage of male and female industrial population. Thirty-seven percent of all compensable claims handled by Liberty Mutual were due to manual handling.

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### ***Awkward Postures***

Awkward postures increase the force required to do a task and compress soft tissues like nerves, vessels and tendons. These postures can occur repetitively or continuously (static postures).

A high prevalence of rotator cuff tendinitis occurs in occupations involving overhead work of long duration, such as shipyard welding (Bernard 1997). An association between neck-shoulder disorders and arm abduction has been seen for less extreme postures, in the range of 0-30° abduction, especially if the work is static.

All non-neutral wrist postures elevate carpal tunnel pressure, and epidemiological studies report that deviated wrist postures are a risk factor for CTS.

There is strong epidemiologic evidence that bending and twisting of the trunk are risk factors of low back disorders. In one study in which exposure was observed from video, risk estimates for both mild (20-45°) and severe (>45°) flexion and trunk twist or lateral bend were high (odds ratios 4.9, 5.7, and 5.9, respectively) and higher than those for lifting (Punnett et al. 1991).

Kneeling more than 4 hours per day has been associated with low back disorders (Bernard 1997). Kneeling and knee bending have been associated with osteoarthritis of the knee in several epidemiological studies (Riihimaki and Viikari-Juntura 1999).

Static postures—postures held over a period of time to resist the force of gravity or to stabilize a work piece—are particularly stressful to the musculoskeletal system. Since blood vessels generally pass through the muscles they supply, static contraction of the muscle can reduce blood flow by as much as 90 percent. The consequent reduction in oxygen and nutrient supply and waste product clearance results in more rapid onset of fatigue and may predispose muscles and other tissues to injury. The increased intramuscular pressure exerted on nerve tissue may result in chronic decrement in nerve function. Light manipulative tasks usually involve a static posture of the neck and shoulder to support the hand. High precision demands require inspection at a close distance that may result in neck flexion, especially if the work object is located at a low level. In

electronics assembly, the average time per work cycle with >20° neck flexion has been associated with neck symptoms.

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### ***Repetition***

Repetition is the frequency with which the same motion or pattern of motions is repeated. High repetition of work movements has been shown to increase the risk of tendinitis of the wrist and CTS (Silverstein 1986, 1987). High repetition combined with high force increases the risk of tendinitis and CTS (Bernard 1997). A high prevalence of rotator cuff tendinitis was found among a group of industrial workers whose work tasks included elevation of the arm above 30° about 10 times per minute (Frost and Andersen 1999). Jobs with the highest risk of wrist tendinitis, CTS, and epicondylitis involve highly repetitive and forceful movements performed in awkward postures of the wrist. Such jobs have shown incidence rates of 13 to 25 per 100 person years for tendinitis and 6 to 11 per 100 person years for epicondylitis (Kurppa 1991).

High repetition may interact with force and posture, but it may also affect tissues independently. For example, increased friction-induced irritation of finger flexor and extensor tendons in their sheaths can result in tendinitis and lead to increased pressure in the carpal tunnel. A modest level of repetition can be protective, since it can increase muscle strength, flexibility and assist blood flow through muscles. Ideal work cycles keep overall repetition rates in a middle zone between the injurious extremes of static contraction and excessive repetition. Brief movement cycles may involve peak accelerations that can exceed tissue elasticity limits during an otherwise moderate task. The biodynamic literature indicates that, even in tasks performed for a short time, the acceleration and velocity of movements may pose risks that would not be predicted by the muscle forces or joint angles alone.

In the office environment, various keying activities are a repetitive task for the fingers while the activity of the shoulder and neck region is static. The distal parts of the limbs, such as the fingers, tolerate much higher movement frequencies than the proximal parts, such as the shoulder. A common finding across studies has been that the increase in duration of intensive keying per day is associated with neck-shoulder and upper extremity disorders, the risk being highest after 4-6 hours of intensive keying per day. The epidemiologic literature on upper extremity WMSDs in video display unit (VDU) operators was recently reviewed by Punnett & Bergqvist (1997). Upper extremity soft-tissue disorders among clerical users were found to be related overall to keyboard use, especially for four or more hours per day and in data entry and similarly intensive or repetitive VDU work.

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### ***Compression***

Compression of tissues can result when moderately sharp edges, such as tool handles, workbench edges, machine corners, and poorly designed seating concentrate forces on a small area of the body, resulting in high, localized pressure. This pressure can compress nerves, vessels, and other soft tissues, resulting in degraded nerve transmission, reduced blood flow, and mechanical damage to tendons and tendon sheaths. These changes may themselves result in disease or predispose other tissues to damage. For instance, the prolonged use of scissors can cause nerve damage on the sides of the fingers. Using the hand or knee as a hammer is another form of external compression, known as impact stress. Using the knee as a hammer has resulted in

prepatellar bursitis commonly called “beat knee” or “carpet layers knee.” Hand hammering has lead to hypothenar hammer syndrome where the ulnar artery that goes through the wrist and palm is destroyed.

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## **Vibration**

Hand arm vibration (HAV) is segmental vibration or vibration transmitted through the hands. It appears to damage both the small blood vessels and the small unmyelinated nerve fibers in the fingers, resulting in two specific diseases: vibration-induced white finger (VWF) and vibratory neuropathy (numbness, loss of finger coordination and dexterity, clumsiness and inability to perform intricate tasks). Together, these are called the hand-arm vibration syndrome or HAVS (Gemne et al., 1987). Segmental vibration has also been implicated in carpal tunnel syndrome. The adverse effects of HAV have been known since 1911 when “dead fingers” were reported among Italian miners using pneumatic tools and since 1918 among US limestone quarry workers using pneumatic tools. Blanching usually starts at the tips of the fingers but progresses as exposure time increases. In very severe cases gangrene will appear at the fingertips. The most important tool sources include pneumatic tools such as grinders, sanders, drills, impact wrenches, jackhammers, riveting and chipping hammers, and chain saws.

Whole-body vibration is transmitted through the lower extremities and/or the back. Whole-body vibration, particularly when sitting on vibrating surfaces such as off road vehicles, tractors, and other vehicles is strongly implicated in low back disorders.

A number of governments and organizations have standards for both segmental and whole body vibration. Wasserman (1998) reviewed various HAV standards. These standards address duration of use and vibration level of the tool, the amount of energy transmitted by the tool over a certain number of hours. For example, 3 hours of exposure to a tool that has a vibration value of 4.1 meters per second squared ( $\text{m/s}^2$ ) would be the equivalent of 2.5  $\text{m/s}^2$  over 8 hours. Thirty minutes exposure to a tool with a vibration value of 10 $\text{m/s}^2$  would be equivalent to 2.5  $\text{m/s}^2$  over 8 hours. ANSI S3.34 (1986) uses weighted vibration measurements and a spectrum analysis. It provides limit values for acceptable daily exposure times for different vibration exposures. The European Standard (Wasserman 1998) calculates the 8-hour energy-equivalent frequency-weighted acceleration sum based on the duration of use. It uses the following limit values: 1  $\text{m/s}^2$  is the threshold level for health risk alerts and preventive measures including worker education; 2.5  $\text{m/s}^2$  is the action level at which values should be put into the instructions and sales literature; 5  $\text{m/s}^2$  is the exposure limit level. The British Standards Institute standard (Wasserman 1998) states that after 8 years of 8-hour exposure to 2.8 $\text{m/s}^2$ , or 2-hours of 5.6 $\text{m/s}^2$ , or 30 minutes at 11.2 $\text{m/s}^2$  at least 10 percent of the exposed population may be expected to have HAVS.

## **Magnitude and Distribution of Exposures in Washington State**

Exposure to risk factors and hazards occur in a wide range of industries. In a recent survey of approximately 5,000 Washington State employers in all industry sectors and sizes (Foley and Silverstein, 1999), employers estimated employees' exposures to 14 risk factors (Table 3). Many types of work involved exposure to physical risk factors, with a subset of workers having prolonged exposures at levels likely to be highly injurious. Among responding employers 43.7 percent reported no employee exposure to any of the risk factors for more than two hours (48.5%

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of employers with 1-10 employees, 33.9% of employers with 11-49 employees and 23.9% of employers with 50 or more employees).

**Table 3. Estimated Percent of Employees Exposed to Physical Risk Factors, Washington State Employer Survey, 1998 (Foley and Silverstein, 1999).**

<b>Risk Factor</b>	<b>No Exposure</b>	<b>Less than 2 hours</b>	<b>2-4 hours</b>	<b>More than 4 hours</b>	<b>Exposure of Unknown Duration</b>
Lift/lower objects above shoulders or below knees while twisting	64.3%	9.9%	3.8%	5.5%	16.5%
Lift 10+ lbs. more than once per minute	79.4%	1.9%	1.6%	2.9%	14.2%
Carry heavy loads (30+pounds) more than 7 feet	74.8%	7.4%	1.0%	1.6%	15.2%
Push/pull heavy loads over 7 feet (heavy load = wheeling 200+ pounds or dragging 60+ pounds)	81.0%	4.3%	0.9%	1.0%	12.8%
Use hand or knee as a hammer	94.4%	0.3%	0.1%	0.1%	5.1%
Use vibrating tools — grinders, impact wrenches, etc.	81.1%	2.8%	1.6%	2.1%	12.4%
Repeatedly pinch small objects or tools between thumb and fingers or hold them a long time	76.7%	2.3%	3.9%	2.7%	14.4%
Work with non-powered hand tools	71.1%	4.1%	3.7%	4.0%	17.1%
Work with hands above shoulder level	78.6%	5.4%	1.7%	2.2%	12.1%
Repetitive movement of whole arm more than twice per minute	71.5%	3.7%	2.8%	6.1%	15.9%
Hold fixed position while working (e.g., microscope work)	81.8%	1.6%	1.1%	2.3%	13.2%
Move lower arm(s) more than 10 times per minute (excludes typing)	72.9%	4.3%	4.2%	6.3%	12.3%
Use keyboard/mouse intensively (data entry)	65.8%	4.6%	4.6%	8.1%	16.9%
Sit on vibrating surfaces, machines, vehicles	83.0%	2.2%	1.1%	2.3%	11.4%

<b>Risk Factor</b>	<b>No Exposure</b>	<b>&lt; Once per shift</b>	<b>1-9 per hour</b>	<b>10+ per hour</b>	<b>Exposure of Unknown Duration</b>
Lift or lower 50 pounds or more unassisted	87.7%	7.6%	3.5%	1.3%	0%

**Strong scientific evidence demonstrates that applying the principles and tools of ergonomics to known risk factors can effectively and inexpensively reduce the hazards to workers, thereby preventing many WMSDs.**

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If exposure to risk factors causes or aggravates WMSDs, then reducing exposures to these risk factors should prevent or reduce WMSDs. Ample evidence in the scientific literature supports this statement (NIOSH, 1997). For example, Smith et al (NRC, 1999) in the National Academy of Sciences report reviewed intervention studies in which changing workstation designs, using mechanical lifting devices, and otherwise reducing risk factors were effective ways of reducing physical load and WMSDs.

In the survey of Washington State employers (Foley and Silverstein, 1999), respondents were asked about the steps they had taken to prevent WMSDs in the previous three years. Overall, 36 percent indicated they had taken prevention steps. The responses varied by size and industry, with fewer small employers taking steps. Of those who had taken steps, larger establishments (50+employees) tended to focus on changing workstations, tools and equipment to reduce human exertion (61 percent), provide protective equipment (62 percent), and provide adjustable workstations or equipment (49 percent). Small establishments (1-10 employees) tended to focus on providing more variety of tasks (52 percent), as well as protective equipment (52 percent) and changing workstations, tools or equipment (48 percent). For those establishments taking prevention steps 53 percent reported a decrease in injuries, 56 percent a decrease in injury severity, 19 percent a decrease in employee turnover and 32 percent a decrease in absenteeism. Improvements in product or service quality were reported by 31 percent and in employee morale by 50 percent. The cost of doing business increased for 15 percent, decreased for 25 percent, and was unchanged for 60 percent of establishments taking prevention steps. Establishments that used engineering or administrative controls reported more success than those using only personal controls such as exercise or personal protective equipment.

In response to a Congressional request, the US General Accounting Office conducted a study on private sector ergonomics programs and concluded they yielded positive results (US GAO, 1997). Core elements of these successful programs included: management commitment, employee involvement, identification of workplace conditions that may cause WMSDs, development of solutions or controls, training and education for employees and appropriate medical management. These core elements were implemented in a variety of ways and at a variety of levels, usually depending on type of industry, product line, company culture and experiences in the evolution of ergonomics programs. Additionally, the GAO study found that "...the processes used by the case study facilities to identify and control problem jobs were typically informal and simple and generally involved a lower level of effort than was reflected in the literature. Controls did not typically require significant investment or resources and did not drastically change the job or operation." (p. 4).

There are similar examples from Washington State. For example, a joint labor-management ergonomics team at an aluminum smelter was successful in reducing posture and force

requirements of carbonsetters, and in reducing the prevalence of WMSDs of the back and upper extremity (SHARP, 1997). There was no change in prevalence among the comparison group of crane operators. The exposure time was cut in half for a number of risk factors including pushing and pulling, handling heavy loads, pinching, and working in awkward postures of the wrist, forearm and shoulder. There was a one-third reduction in the duration that workers were exposed to awkward trunk postures. There was a fifty-percent reduction in the prevalence of shoulder, elbow, and back disorders. Hand/wrist disorders were reduced by one-third.

In another project, a team of data entry operators and supervisors at the Department of Labor & Industries reduced intensive keying time to less than 5 hours, increased task variety, and improved workstations and chairs (Silverstein, et al, 1993). That resulted in eliminating back and neck disorders and reducing hand/wrist disorders by more than one-third. In contrast, there are a number of studies that show training alone, in the absence of actual improvements in the workplace, is not particularly effective in reducing WMSDs (Daltroy et al, 1997; SHARP, 1993).

**The scientific evidence and industry experience regarding the positive impact of reducing worker exposure to physical risk factors has been translated into a number of practical control strategies found in numerous ergonomics textbooks and guides.**

For example, with respect to manual handling hazards, there are a number of solutions available:

- To reduce bending motions, use lift tables, work dispensers, simple mechanical aids, raise the work level to the appropriate height, lower the employee, provide and keep materials around waist height.
- To reduce twisting motions, provide materials/tools in front of the employee, use conveyers, chutes, slides, turntables to change direction of material flow.
- To reduce reaching motions, provide tool and machine controls within 16 inches of the operator, place the heaviest objects as close as possible to the employee, reduce the size of cartons or pallets being loaded or insure that the employee can walk around them or rotate them, reduce the size of the object being handled, keep the object close to the body, eliminate unnecessary barriers.
- To reduce lifting/lowering forces, use lift tables, hoists, cranes, balancers, industrial manipulators, drum and barrel dumpers, gravity chutes, slides or other mechanical aids; increase the weight of the object so it can only be handled mechanically, provide grips or handles, reduce the weight of the object or container.

Examples of controls for upper or lower extremity hazards include:

- Reduce awkward postures by designing tasks that can be performed with elbow at the side of the body and without excessive forearm or wrist deviation
- Reduce repetition by increasing task variety and rotating to jobs with different muscle use. Provide mechanical assists or multifunctional tools. Change the process (e.g., changing from 4 bolts to 2 clips). Allow time to recover.

- Reduce high hand forces by changing the size or shape of objects held in the hand. Increase friction of materials on surface of the object to reduce slipperiness. Grasp objects with a power grip rather than a pinch grip. Reduce the weight handled by going from one-handed to two-handed grip. Grasp objects at the center of gravity to reduce torque on the joints. Balance tools. Use mechanical assists. Use roller or power conveyors for moving parts, replace or service dull or worn tools, and avoid use of tight or bulky gloves
- Avoid methods that create static postures. Control postures through the location and orientation of the work surface or through the size and shape of objects held in the hand.
- Reduce impact stress by padding the hand, eliminating or padding hard or sharp objects that come into contact with soft tissues, using mechanical devices instead of the knee or hand as a hammer, providing soft kneepad cushions for kneeling work.
- Reduce hand arm vibration hazards by using tools with declared vibration values of 2.5 meters per second squared ( $2\text{m/s}^2$ ) [these values should be available from the manufacturer] and providing preventive maintenance of all power tools. Reduce amount of vibration entering the hands by using air-cushioned cylinders, air shutoff clutches or properly selected isolation mounts. De-couple the vibration from the hand by using tool stands, isolated fixtures or isolated handles. Introduce recovery breaks.
- Reduce whole body vibration to drivers by improving vehicle suspension, using vibration isolation or dampening characteristics for seating.

**Ten years of voluntary activities have been useful and necessary but not sufficient to address the problem. Existing general rules have not been adequate because they do not provide employers, employees or L&I staff with clear statements regarding which exposures must be controlled and how the department will assess employer compliance.**

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**L&I has provided non-regulatory assistance to employers and employees to reduce WMSDs for more than ten years.**

Since the late 1980's, the primary emphasis of L&I's actions to reduce WMSDs has been voluntary programs and research activities, including:

- Hiring professional ergonomists to conduct research and assist employers on request;
- Working with employer and employee representatives to develop a number of guidelines on workplace ergonomics such as "Ergonomic Program Guidelines" and "Office Ergonomics Guidelines";
- Providing free employer workshops on industrial and office ergonomics;
- Publishing statistics on WMSDs from state workers' compensation data;
- Providing training to L&I staff on workplace ergonomics;

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- Conducting research studies in various industries on workplace ergonomics, focusing on identifying and controlling hazards;
- Developing industry-wide initiatives to promote the reduction of risk factors for WMSDs;
- Developing and maintaining an ergonomics web site;
- Providing access to free ergonomics training and information videos; and
- Highlighting ergonomics and reduction of WMSD hazards at the annual Washington State Governor's Safety and Health Conference.

During this same period, numerous private companies, consultants, safety and health journals, safety and health professionals, labor unions and others have also encouraged and assisted employers in the voluntary use of ergonomics to eliminate or reduce risk factors leading to WMSDs.

**High numbers, high rates, and high costs of WMSDs still occur.**

In spite of these intensive voluntary efforts, data from the state workers' compensation system shows that WMSDs still account for unacceptably high numbers of claims and very high claim costs (Silverstein & Kalat 1999b). See previous discussion under "WMSDs occur in Washington workplaces in numbers and at rates that are too high for government to ignore. They are widespread and preventable".

**L&I's employer survey shows that WMSD risks are not being addressed by many businesses.**

The survey of Washington State employers (Foley & Silverstein, 1999) conducted in 1998 included all industry sectors in the state other than mining and maritime. A high response rate indicated that the survey was representative of all state employers. Among the findings:

- Risk factors for WMSDs were prevalent in all industry types and sizes of workplaces.
- Only about one-third of employers had taken steps to prevent or reduce WMSDs. These employers generally reported that their actions were successful. Many of these employers reported that steps to reduce WMSDs resulted in benefits beyond a reduction in the number or severity of problems. These benefits included improved product or service quality, improved morale, and reduced absenteeism.
- Almost two-thirds of all employers surveyed reported that they had not taken prevention steps, although 90 percent of firms reported having employees exposed to some workplace risk factors. Even among employers who said they had WMSDs occur in their workplaces over the last 3 years, almost 40 percent reported they were taking no steps to prevent them.

**Addressing WMSD hazards through the enforcement of existing general rules has been inadequate, and this approach has been resisted strongly by business representatives.**

Existing rules such as the Accident Prevention Program standard (WAC 296-24-040), Management's Responsibility (WAC 296-24-020) and the Safeplace Standards (WAC 296-24-073) have been used to address WMSD hazards in the past. Using these existing rules is inadequate for a number of reasons:

- The existing Accident Prevention Program Standard and Management's Responsibility requirements provide little guidance to an employer on what they actually need to do to effectively address WMSD hazards. They only require an employer to take some action to address hazards in general. These standards do not provide employers, employees or L&I staff with clear statements regarding which exposures must be controlled and how the department will assess employer compliance.
- The “safeplace standard/general duty clause” is typically cited only in response to a pattern of injuries that have already occurred. This approach is inherently inefficient, as it requires a case-by-case determination that hazards are recognized and that specific feasible controls are known. Employers have little way to know whether they are in compliance before an inspection occurs.
- Business representatives have strongly resisted efforts to establish clear agency policies for using existing rules in more specific ways to address WMSD hazards. They have argued that this would be *de facto* rulemaking and have advocated formal rule making over this policy approach.

### **The consequences of not adopting a rule would be serious.**

If a rule is not adopted as part of a comprehensive strategy, the large amount of pain and suffering caused by WMSDs will either continue or decline too slowly. WMSDs will continue to be the largest unregulated cause of injury in the state.

The direct medical and time loss costs alone will continue to exceed hundreds of millions of dollars each year. These costs do not include the indirect and societal costs related to these disorders.

The department will not be able to address adequately the statutory objective of RCW 49.17 - to assure that no employee will suffer material impairment of health or functional capacity for the period of their working life.

**L&I has considered non-rulemaking alternatives as well as alternative rulemaking options. The proposed rule was designed to be the most fair, effective, efficient and least burdensome alternative.**

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### **Alternatives to rule making**

The department considered three primary alternatives to rule making:

1. Relying on existing and additional voluntary efforts;
2. Using existing regulations to address WMSD hazards; and
3. Waiting for federal OSHA to promulgate an ergonomics rule.

As noted above, the department has been working with employers and others on voluntary efforts to reduce WMSDs for well over 10 years. While these efforts have been somewhat successful, they have proved insufficient. Washington continues to amass large numbers of workers' compensation claims for WMSDs at a very high cost. Stepped up outreach services and technical assistance definitely have a role in the future. However, alone they will not be adequate to address and reduce WMSD hazards.

L&I also determined that relying on existing regulations to address WMSD hazards would be an inadequate alternative to rule making. These existing rules are very general, and provide little or no guidance to employers on which exposures to control, how to control them, or how the department will assess compliance. If L&I were to use existing general regulations more effectively it would be necessary to develop more specific compliance and inspection guidelines, but business organizations have argued that this would be *de facto* rulemaking.

Another alternative to rule making is waiting for the federal government to promulgate rules on ergonomics. This alternative was rejected because waiting for OSHA is unpredictable, and waiting means more Washington workers will suffer WMSDs that could be prevented. Washington also has the opportunity to fashion a rule that reflects the input of Washington State employers and employees and takes into account specific features of the state's worker compensation system, safety and health system, and industry demographics.

Congress delegated authority to the states to establish occupational safety and health programs, as long as they were at least as effective as the federal government's. Washington accepted that authority in 1973, and adopted the Washington Industrial Safety and Health Act (WISHA). Washington has often used this authority to develop creative approaches to occupational safety and health that are tailored for Washington workplaces.

## **Effectiveness of regulation**

Regulations have proven effective at helping to reduce injuries and illnesses:

- In a study of compensable claims related to falls in the Washington state construction industry (Nelson et al. 1997), L&I researchers found that cited employers were 2.3 times as likely as controls (construction employers who were not cited) to experience a claim rate reduction.
- Studies of federal OSHA compliance programs have also demonstrated the effectiveness of safety and health regulations. For example, there were approximately 60 percent fewer deaths from dust-related fires and explosions in grain-handling industries after OSHA's 1987 standard that addressed these hazards (U.S. Congress Office of Technology Assessment, 1995). A study of 6,842 manufacturing businesses (Gray and Scholz, 1993) found that

inspections imposing a penalty reduced injuries by 22 percent over a 3-year period, and reduced lost workdays by 20 percent.

- Published reviews of the technical and public policy issues surrounding OSHA enforcement programs (McQuiston et al. 1998, Shapiro and Rabinowitz, 1997) have concluded that regulations and enforcement play an important role to help assure workplace health and safety. These reviews also acknowledge the important role of voluntary compliance, in conjunction with enforcement programs, in helping to reduce workplace injuries.
- Other regulatory programs have proven effective at reducing injuries or promoting safe practices. For example, Robertson, 1996 reported that automobile deaths have been substantially reduced as a result of required seat belt use. In another study (Ferguson et al. 1999), seat belt use among taxicab drivers in the District of Columbia was found to be much higher than in other areas that did not have strong seat belt use laws to protect these workers.

### **Alternative regulatory options explored by the department**

The department carefully considered a number of alternative approaches for a proposed rule. The department provided detailed information and held discussions on the strengths and weaknesses of alternate approaches with two advisory committees. The advisory committees were also provided copies of existing U.S., Canadian, European, and Australian ergonomic standards and ergonomics proposals for reference and discussion. Some of the major alternate approaches considered were:

- An injury-based rule - where the "trigger" for applying the rule would be the occurrence of WMSDs or symptoms in a workplace.

An injury-based rule was rejected in favor of a rule based on reducing hazards for WMSDs. Reasons why an injury-based rule was rejected included:

- It would not be as preventative as other WISHA safety and health standards, and would require employees to be injured before any action was taken.
  - What constitutes a WMSD would become the major focus rather than finding and fixing hazards to prevent WMSDs. The issue of whether a particular injury was caused or aggravated at work or at home would become a significant issue.
  - It would foster under-reporting of WMSDs.
  - Since WMSDs are often cumulative in nature, an employer with transient employees or high turnover would be required to address problems of employees that may not have arisen from hazards at their worksite.
  - An injury-based rule might conflict with worker compensation laws and rules.
- A rule that would be "specification-based" only or "general performance-based" only. The department heard persuasive arguments for both these approaches.

Specification-based rules (where the department would identify specific criteria that an employer would meet in order to be in compliance) were suggested by a number of people, especially small employers with limited resources for exploring different ways of achieving

compliance. They emphasized the need for clear specific instructions to know what they were required to do to comply.

General performance-based rules (where the department would allow different types of actions, not specified, to achieve an objective) were also suggested by a number of people, especially large businesses with resources to explore different ways of achieving compliance.

The department chose to include both approaches for analyzing and controlling WMSD hazards. This will allow employers to choose a set of specific criteria and know very clearly what they need to do to be in compliance, or choose a general approach that will allow more flexibility.

- Rules that would require ergonomics programs for all employers in the state.

A number of people, recognizing that WMSD hazards are widespread throughout many industries, suggested all employers should provide ergonomics training and analyze their jobs to determine if WMSD hazards were present, then control identified hazards.

The department instead chose to have the rule apply only to those employers who had jobs with a sufficient degree of risk that would warrant ergonomics awareness education and job hazard analysis to identify WMSD hazards needing controls.

The approach chosen for the proposed rule focuses employer (and department) resources on those jobs most likely to have WMSD hazards. No resources are spent on jobs where there is no or only low risk of injury. Criteria for "caution zone jobs," intended to be used to make a very quick decision on the presence of jobs with a sufficient degree of risk for further action, are provided in Part 1 of the proposed rule.

- A rule that would be designed to cover all types of WMSDs, not just non-traumatic, soft-tissue WMSDs.

This approach was considered because the general principle of ergonomics, fitting the job to the worker, is applicable to all types of workplace injuries and illnesses. In addition, other examples of ergonomics rules (e.g. British Columbia) or proposed ergonomics rules (e.g. North Carolina) did not distinguish between types of soft-tissue WMSDs.

This alternative was rejected because existing WISHA rules already address many of the traumatic injuries.

- A proposed rule that would exempt certain types of employers such as construction, agriculture, or small business.

This alternative was based on concerns such as the difficulty of providing education and other requirements for a transient or seasonal workforce, the difficulty of controlling some WMSD hazards in outdoor or highly "changeable" environments, or to lessen the regulatory burden for employers who have limited resources.

The department did not choose to exempt these employer groups from the proposed rule for the following reasons:

- A large number of employees would not be protected from WMSD hazards.
- The statute that this rule implements (RCW 49.17) provides for the protection of all employees from hazards that cause material impairment of health or functional capacity.
- Other WISHA safety and health rules apply to these groups, where hazards are present.
- Some of these employers have jobs that are at very high risk for WMSD hazards.

However, a number of elements were incorporated in the proposal to address the identified concerns of these employer groups:

- A phased-in implementation schedule that allows most small employers the maximum length of time (up to 6 years) to control WMSD hazards. Small employers in selected high-risk industries would have up to 4 years to control WMSD hazards.
- The phased implementation schedule also allows small employers to take advantage of methods and controls used by larger firms that comply earlier. Also included in the implementation plan is help from the department, intended particularly for small businesses, to collect and share the most effective examples of ergonomics training, job analysis, and specific controls.
- Ergonomics awareness education can "move" with an employee. The employer, another employer, or some other organization could provide the awareness education. This provision will be especially useful for employers with a transient workforce.
- Employer choice provisions allow and encourage flexibility to match the needs in particular industries. Although there is only one ergonomics proposal, it is not a one-size-fits-all proposal.
- While an injury-based rule would create particular problems for employers with a transient work force, the proposed approach to reduce identified hazards allows them to control the hazards that exist in their particular operation.

**The Department determined the proposed rule to be the least burdensome alternative that meets statutory goals.**

The department determined that rule-making and voluntary efforts are essential components of a comprehensive approach to decrease WMSDs in Washington workplaces.

Although voluntary activities have apparently been successful in reducing WMSDs to some degree, continuing high numbers and costs of worker's compensation claims and a large survey of Washington employers indicates they have not been sufficient.

Department data as well as information from the literature regarding OSHA enforcement and other regulatory activities show that regulations can be effective in helping to reduce injuries.

The department considered a wide range of alternatives for the proposed rule and discussed these different approaches with advisory committee members. In addition, the department drew on ideas taken from the advisory committee meetings to guide the development of a proposed rule.

- Taken together, these considerations led the department to the conclusion that the proposed rule is reasonable, responds to concerns identified in the public process, and is the least burdensome alternative that will meet the statutory mandate to assure that no employee will suffer material impairment of health or functional capacity for the period of their working life.

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**The proposed rule will be economically and technologically feasible. The department believes that the benefits of the rule will far outweigh its costs.**

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The cost estimates from the small business economic impact statement compared with only the direct medical and partial wage replacement costs of WMSDs in the state's workers' compensation system indicate the probable benefits of a rule will be greater than the probable costs. Considering additional indirect costs associated with WMSDs, the probable benefits of the rule are likely to far outweigh its costs. Analysis of benefits vs. costs will be addressed in detail for the final rule.

Many examples exist to show that ergonomic tools can be used effectively to reduce exposure to WMSD hazards and thereby prevent many WMSDs. Furthermore, these ergonomic tools are not necessarily complicated or costly and can result in a number of benefits in addition to reduced WMSDs, such as better employee morale, a decrease in absenteeism, and better product quality.

Because the proposed rule only requires employers to do what is feasible, no employer will be unfairly burdened by the rule. The concept of feasibility in worker safety standards is well established in the courts, and has always provided flexibility to employers.

In determining whether it is feasible for an employer to comply with a rule, the following factors are generally considered:

- Whether compliance with the rule is physically possible, and whether it precludes performance of the required work.
- Whether alternative means of employee protection are either in use or available.
- The costs of compliance, and whether the employer cannot absorb or pass on the cost.

**The department has completed a Small Business Economic Impact Statement (SBEIS). Despite little evidence that the proposed rule will pose an unfair burden on small employers, the department recognizes that small businesses face inherent disadvantages that might not be fully demonstrated in the analysis. Therefore, the**

## **department has chosen to make special allowances to mitigate the potential costs and impacts on small businesses.**

Using a combination of information from employer surveys and labor market information, the SBEIS estimated that the cost per employee would be less than 10 cents per day and the average overall costs per employer less than 0.025 percent of sales. Overall, and in eight of 10 one-digit SIC industry categories examined, average overall costs per employee were found to be lower for small employers than for large employers. Costs as a percent of sales were somewhat higher for small businesses than for large. In spite of a lack of overall evidence that there was a disproportionate cost to small businesses compared to large businesses, the department decided to make special allowances to mitigate potential costs for small businesses:

- Significantly more time for small businesses to comply with the rule. This will allow small businesses to take advantage of methods and controls used by larger employers who need to comply earlier.
- The implementation plan includes substantial efforts by the department to provide assistance for small businesses in preparing for the rule during the phase-in period.
- Employers will have options for analyzing and controlling WMSD hazards. This includes very specific criteria to follow or the choice of using other criteria that may better meet the employers' needs.
- The department's method of assessing penalties for violations of rules allows a very substantial penalty reduction for small employers.

## **The proposed rule is designed to be fair, flexible and feasible. Fifteen key ideas emerged from advisory committee deliberations, which were used to help shape the proposal.**

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The department identified 15 ideas drawn from advisory committee discussions to guide the development of the proposed rule. These ideas, and a brief description of how they were incorporated in the proposal, are listed below:

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### ***1) The proposed rule will be short and written in a clear, easy-to-understand format.***

The proposed rule is less than 10 double-spaced pages. A short Appendix (296-62-05174) was added to include detailed criteria as one option for analyzing and controlling WMSD hazards.

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***2) The proposal will take a preventative approach.***

The focus of the proposed rule is on identifying known physical hazards for WMSDs and then reducing these hazards to prevent WMSDs. Employees do not have to be injured before any action is taken to prevent WMSDs.

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***3) The proposal's goal will be to eliminate or reduce hazards for work-related, non-traumatic, soft tissue musculoskeletal disorders (not including injuries from slips, falls, motor vehicle accidents).***

The proposed rule specifically states the intent is to reduce non-traumatic, soft tissue WMSDs such as carpal tunnel syndrome, tendinitis, low back disorders, and rotator cuff syndrome. The proposal does not address injuries from slips, trips, falls, motor vehicle accidents, or being struck by or caught in objects.

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***4) The focus of the proposal will be preventing WMSDs. It is not intended to address the medical treatment of work-related injuries or affect workers' compensation practices.***

Medical management issues for injured workers are not addressed in the proposed rule, nor does it include any language regarding current workers' compensation practices. The proposed rule focuses entirely on injury prevention.

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***5) Employee involvement will be an essential element of the proposal.***

The proposed rule includes a section that requires employee involvement in the analysis and control of WMSD hazards. An annual review of ergonomic activities also includes employee involvement.

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***6) In workplaces where there are only minor risks related to musculoskeletal disorders, employers would not be required to do as much as employers whose workplaces have significant hazards.***

Part 1 of the proposed rule provides a quick way for employers to determine whether they are covered. It provides criteria for identifying any "caution zone jobs". Employers with caution zone jobs are required to provide those employees working in or supervising these jobs with basic awareness education on ergonomics and analyze these jobs to determine if they have WMSD hazards. Employers are only required to fix jobs where the job analysis reveals that a WMSD hazard exists.

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***7) The proposal will recognize that finding permanent solutions to fix some hazardous jobs could take time.***

The proposed rule includes an implementation schedule that allows between 3 to 6 years to reduce WMSD hazards, depending on the type and size of the business. Small employers are given the maximum amount of time. The proposal requires employers to reduce WMSD hazards

below established criteria or to the degree feasible. This recognizes that there may be some circumstances where controls for WMSDs hazards may not yet be feasible.

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***8) The proposal will allow basic awareness education to be “portable” between employers.***

The proposed rule allows ergonomics awareness education to "move" with an employee. The employer, another employer, or some other organization could provide the awareness education.

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***9) Record keeping requirements in the proposal will be limited.***

The proposed rule does not contain any specific record keeping or written program requirements. If employers choose the general performance approach to analyze and control WMSD hazards they need to be able to demonstrate what criteria were used to identify a WMSD hazard and that any hazards have been reduced below the criteria or to the degree feasible. Where employers rely on ergonomics programs in place before the proposed rule's adoption date, they need to be able to demonstrate that the program is as effective as the proposed rule in reducing WMSD hazards.

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***10) Existing ergonomics programs that meet the basic requirements of the proposal will be considered “in compliance.”***

The proposed rule allows employers to use alternative methods established before the rule's adoption date. These methods, taken as a whole, must be as effective as the proposed rule in reducing WMSD hazards of each job and provide for employee education, training, and participation.

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***11) Delayed enforcement provisions will be part of the proposed implementation plan to allow time for employers and employees to learn what the rule requires, try things out, and come into compliance before each element of the rule is enforced.***

The proposed rule includes an implementation schedule that allows 3 to 6 years for employers to fix WMSD hazards, depending on the type and size of business. Certain large employers (50 or more employees) in industries with high rates and numbers of workers' compensation claims resulting in four or more days off work are required to comply the earliest. The twelve 3-digit SIC industries with the highest risk for WMSDs were chosen using 1995-1997 "Prevention Index" rankings (an average of the rank for both numbers of compensable WMSD claims and WMSD compensable claims incidence rates). Small employers (10 or fewer employees) that are not in the 12 highest risk industries have the longest time to comply.

The three main components of the proposed rule - awareness education, job analysis, and hazard reduction - are also phased-in over time to allow a logical sequence for time and resource allocation during implementation. The implementation schedule allows ample time for employers and employees to learn, plan, and conduct ergonomics activities to comply with the rule.

New businesses established after the end of the implementation schedule are provided over a year to implement the requirements. Significant changes to existing businesses or workplaces

(after the initial implementation dates have passed) are allowed from 1-3 months for implementation.

The implementation plan also includes the development of guides and models. For example, department staff will work with employer and employee organizations to develop a model program for ergonomics awareness education. This material will be made available through pamphlets, the Internet, and in free workshops and consultations.

The department will continue free employer workshops, guidelines and training materials, presentations at conferences, free employer consultations, special industry initiatives, research, and an ergonomics web page. Department staff will also work with employer and employee organizations to collect and share the most effective examples of ergonomic training, job analysis, and specific solutions to hazards. The department will make special efforts to share this information with the small business community.

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***12) The development of industry-specific "best practices" will be encouraged as part of the implementation plan, but will not be a required part of the proposed rule.***

The department has already started meetings with interested individuals from labor, management, and the health professions to develop additional ergonomics technical assistance materials. Industry-specific best practices are one of the assistance "tools" being discussed and considered. However, the proposed rule does not require employers to develop or use best practices.

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***13) The proposed implementation plan will include comprehensive training for L&I inspectors and consultants on the new rule. Regional workshops and site visits will also be offered before enforcement begins to give employers and employees an opportunity to learn how the rule would apply to their particular business.***

The department will establish policies and procedures for inspections and enforcement prior to the first effective date. The department will train staff on these policies and procedures, and communicate them to employers and employees before citations or penalties are issued. In addition, the department will work with a group of Demonstration Employers to test and improve guidelines, best practices, and inspection policies and procedures as they are developed.

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***14) Small business resource concerns will be taken into account in the proposed rule and implementation plan.***

The proposed rule allows small businesses (10 or fewer employees) significantly more time than larger businesses to comply. Small businesses in the twelve highest risk industries have 4 years to provide controls for jobs with WMSD hazards. Employers in lower risk industries with 11-49 employees have 5 years to control WMSD hazards. All other small businesses have 6 years to control WMSD hazards.

The phased implementation schedule will allow small businesses to take advantage of methods and controls used by larger firms that comply earlier. Also, the department intends to collect and share with small businesses the most effective examples of ergonomics training, job analysis, and specific controls.

A specification-based option for analyzing and controlling WMSD hazards was included in the proposed rule which can be used by firms, such as many small businesses, that want to know clearly what they need to do to comply.

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***15) The proposal will not impose a one-size-fits-all approach. The goal is to strike a balance between general performance-based elements and some specifics so that the requirements are flexible, and yet employers and employees will know clearly what to do.***

The proposed rule includes both general performance and specific performance options for analyzing and controlling WMSD hazards. This provides flexibility for employers to choose what works best for them.

Employers can continue to use existing, effective ergonomics programs that meet the basic requirements of the proposed rule.

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## Appendix A

### Industry Ranks for Non-Traumatic WMSDs, State Fund and Self-Insured, Compensable Claims 1995-1997, Three Digit SIC

Industry	Ranking by Claims Rate	Industry	Ranking by Numbers of Claims	Industry	Ranking by Prevention Index
Air Transportation, Scheduled, & Air Courier Services (451)	1	Grocery Stores (541)	1	Trucking & Courier Services, Except Air (421)	1
Roofing, Siding & Sheet Metal Work (176)	2	Trucking & Courier Services, Except Air (421)	2	Air Transportation, Scheduled, and Air Courier Services (451)	2
Trucking & Courier Services, Except Air (421)	3	Hospitals (806)	3	Nursing & Personal Care Facilities (805)	3
Local & Suburban Passenger Transportation (411)	4	Aircraft & Parts (372)	4	Masonry, Stonework, Tile Setting and Plastering (174)	4
Concrete Work (177)	5	Eating & Drinking Places (581)	5	General Building Contractors - Residential Buildings (152)	5
Administration of Veterans' Affairs, Except Health & Injury (945)	6	Elementary & Secondary Schools (821)	6	Roofing, Siding, And Sheet Metal Work (176)	6
Rolling, Drawing & Extruding of Nonferrous Metals (335)	7	Nursing & Personal Care Facilities (805)	7	Grocery Stores (541)	7
School Buses (415)	8	General Building Contractors - Residential Buildings (152)	8	Carpentry & Floor Work (175)	8

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<b>Industry</b>	<b>Ranking by Claims Rate</b>	<b>Industry</b>	<b>Ranking by Numbers of Claims</b>	<b>Industry</b>	<b>Ranking by Prevention Index</b>
Intercity & Rural Bus Transportation (413)	9	Personnel Supply Services (736)	9	Services to Dwellings & Other Buildings (734)	9
Nursing & Personal Care Facilities (805)	10	Air Transportation, Scheduled, & Air Courier Services (451)	10	Local & Suburban Passenger Transportation (411)	10
Carpentry & Floor Work (175)	11	Groceries & Related Products (514)	11	Concrete Work (177)	11
Dairy Products (202)	12	Executive & Legislative Offices Combined (913)	12	Sawmills & Planing Mills (242)	12
Masonry, Stonework, Tile Setting & Plastering (174)	13	Plumbing, Heating & Air-Conditioning (171)	13	Residential Care (836)	13
Ship & Boat Building & Repairing (373)	14	Masonry, Stonework, Tile Setting & Plastering (174)	14	Libraries (823)	14
Sanitary Services (495)	15	Libraries (823)	15	Misc. Special Trade Contractors (179)	15
Metal Cans & Shipping Containers (341)	16	General Government, Not Elsewhere Classified (919)	16	Rolling, Drawing & Extruding of Nonferrous Metals (335)	16
Converted Paper & Paperboards Products, Except Containers (267)	17	Department Stores (531)	17	Plumbing, Heating and Air-Conditioning (171)	17
Paper Mills (262)	18	Misc. Special Trade Contractors (179)	18	Executive & Legislative Offices Combined (913)	18
General Building Contractors - Residential Buildings (152)	19	Logging (241)	19	Paper Mills (262)	19
Wood Containers (244)	20	Services to Dwellings & Other Buildings (734)	20	Ship & Boat Building & Repairing (373)	20

Industry Ranks for Non-Traumatic WMSDs, State Fund and Self-Insured,  
Compensable Claims 1995-1997, Two Digit SIC

Industry	Ranking by Claims Rate	Industry	Ranking by Numbers of Claims	Industry	Ranking by Prevention Index
Motor Freight Transportation & Warehousing (42)	1	Health Services (80)	1	Motor Freight Transportation & Warehousing (42)	1
Transportation by Air (45)	2	Construction Special Trade Contractors (17)	2	Construction Special Trade Contractors (17)	2
Local & Suburban Transit & Interurban Hwy Passenger Transit (41)	3	Educational Services (82)	3	Food Stores (54)	3
Construction Special Trade Contractors (17)	4	Food Stores (54)	4	Transportation by Air (45)	4
Building Construction - General Contractors & Operative (15)	5	Motor Freight Transportation & Warehousing (42)	5	Building Construction - General Contractors & Operative (15)	5
Furniture & Fixtures (25)	6	Transportation Equipment (37)	6	Lumber & Wood Products, Except Furniture (24)	6
Paper & Allied Products (26)	7	Business Services (73)	7	Health Services (80)	7
Food Stores (54)	8	Eating & Drinking Places (58)	8	Food & Kindred Products (20)	8
Primary Metal Industries (33)	9	Executive, Legislative & General Government, Except F (91)	9	Executive, Legislative & General Government, Except F (91)	9
Lumber & Wood products, Except Furniture (24)	10	Lumber & Wood Products, Except Furniture (24)	10	Primary Metal Industries (33)	10

**Department of Labor and Industries**  
**WISHA Services Division**

<b>Industry</b>	<b>Ranking by Claims Rate</b>	<b>Industry</b>	<b>Ranking by Numbers of Claims</b>	<b>Industry</b>	<b>Ranking by Prevention Index</b>
Heavy Construction Other Than Building Construction - Contractors (16)	11	Wholesale Trade - Nondurable Goods (51)	11	Paper & Allied Products (26)	11
Food & Kindred Products (20)	12	Wholesale Trade - Durable Goods (50)	12	Heavy Construction Other Than Building Construction - Contractors (16)	12
Stone, Clay, Glass & Concrete Products (32)	13	Building Construction - General Contractors & Operative (15)	13	Local & Suburban Transit & Interurban Hwy Passenger Tran (41)	13
Fabricated Metal Products, Except Machinery & Transportation (34)	14	Food & Kindred Products (20)	14	Transportation Equipment (37)	14
Oil & Gas Extraction (13)	15	Automotive Dealers & Gasoline Service Stations (55)	15	General Merchandise Stores (53)	15
Mining & Quarrying of Nonmetallic Minerals, Except Fuels (14)	16	Transportation by Air (45)	16	Wholesale Trade - Nondurable Goods (51)	16
Rubber & Misc. Plastics Products (30)	17	General Merchandise Stores (53)	17	Building Materials, Hardware, Garden Supply & Mobile Homes (52)	17
General Merchandise Stores (53)	18	Hotels, Rooming Houses, Camps and Other Lodging Places (70)	18	Fabricated Metal Products, Except Machinery & Transportation (34)	18
Building Materials, Hardware, Garden Supply & Mobile Homes (52)	19	Social Services (83)	19	Hotels, Rooming Houses, Camps and Other Lodging Places (70)	19
Electric, Gas and Sanitary Services (49)	20	Miscellaneous Retail (59)	20	Business Services (73)	20

